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EXPERIMENTS IN ELECTRICAL ANÆSTHESIA AND BARBITURATE BASAL NARCOSIS

BY

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FOR many years it has been recognised that a state indistinguishable from anæsthesia can be produced in animals by the passage of a direct electric current from head to tail, whereas tetanic spasm is produced by a similar current passing from tail to head (Mach,[1] Hermann,[2] Blasius and Schweizer,[3] Nagel,[4] Burge *et al.*[5]

In recent years the nature of this phenomenon has been extensively investigated by Scheminzky,[6] Scheminzky and Scheminzky,[7] Scheminzky[8] and Köllensperger and Scheminzky[9] on minnows and frogs, and by Burge *et al.*[10] on small mammals. These workers showed that the descending current produces an anæsthetic state by acting on the central nervous system including the spinal cord (the effect can be produced in decerebrate animals), and not on the peripheral nervous system; and that the state is accompanied by a change of electrical potential in the brain, identical to that observed during anæsthesia produced by chemical substances such as ether.

In the present investigations minnows have been employed. Accumulators with a total voltage of 26 provided the source of the direct current, and the circuit included a glass tank ($5\frac{3}{4}''$ x $3\frac{1}{8}''$ x $4\frac{5}{16}''$) with the smaller sides covered on the

inside by carbon plate electrodes; a reversing switch; a milliammeter; and an adjustable resistance. The tank was filled with tap water from a storage receptacle, in order to avoid variations in the resistance of tap water drawn on different days.

The earlier experiments were repeated with similar results. Gradual increments to a current which had no visible effect at first, caused increasing excitement; next the fish turned its head towards the positive pole and its movements became incoordinate; and finally it fell to the bottom of the tank, where it lay motionless on its side and did not react to touch. As the current was reduced, the fish rose and swam about normally, showing no after-effects. The longer the state of apparent anæsthesia was allowed to persist, the longer was recovery delayed; but even after the passage of the anæsthetic current-dose for one minute, the delay was only a few seconds. If the fish was repeatedly anæsthetised, nearly the same current-dose was required each time; thus no decreasing resistance to the current was noted in a fish which was anæsthetised 30 times in succession, each period of anæsthesia being a few seconds and each interval 3-5 minutes.

The effect of injecting a narcotic drug before passing the direct current was next tested. When one-half of the smallest dose which had a just-visible narcotic effect on the fish was injected into the peritoneal cavity, no narcotic effect could be observed, but it was possible to anæsthetise the fish with a markedly smaller current-dose than before. When successive readings were taken, it was found that after the injection there was a gradual reduction in current-dose necessary to produce anæsthesia, until a minimal reading was obtained; thereafter there was a rise until the same amount of current was necessary as before the injection. When distilled water was injected into the fish, no such effect was observed, the readings being similar to the ones obtained in the non-injected fish. It appeared that such drugs had the effect of reducing the resistance of the central nervous system of the fish to the current, and this difference could be accurately determined by the milliammeter. By this technique a comparative study was made of the common short-acting barbiturates, to demonstrate the effect of different drugs on the same fish, and the effect of a single drug on different fish.

Technique of Present Experiments.

Minnows of varying sizes were selected, and given injections of empirical doses of the drug to be tested. The smallest dose which had a visible narcotic effect was noted, and one-half of that dose was used for the experiments. When comparing pentothal-sodium and cyclonal-sodium it was noted that pentothal-sodium was a decidedly more powerful drug, and therefore the dose of pentothal-sodium administered was one-half that of cyclonal-sodium. All other barbiturates were used in the same dose as cyclonal-sodium. The fish were given at least 24 hours, and usually much longer, to recover from each injection before being tested again.

Controls: Each dose of drug was dissolved in 0.1 c.c. of distilled water. Control injections of 0.1 c.c. of distilled water were given into the peritoneal cavity, and readings taken at 5-minute intervals for 75 minutes, except in fish No. 5.

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EARLY ISSUES

The Editor has received many requests for the back issues of the Journal which are out of print. If sufficient subscribers are forthcoming the Editorial Board is prepared to reproduce, probably by photographic process, the early numbers which will be bound several volumes together without advertising matter.

Will subscribers who wish to obtain any of these early issues please inform the Editor, at 57 Church Street, Isleworth, Middlesex.

Chart I (fish No. 1) shows that after the injection of 0.1 c.c. distilled water, the amount of current necessary to produce anæsthesia was essentially the same as before. Slight diminutions were noted in certain fish (Chart I, lines B and D), which leaped out of the tank during the induction of anæsthesia, and were slightly stunned.

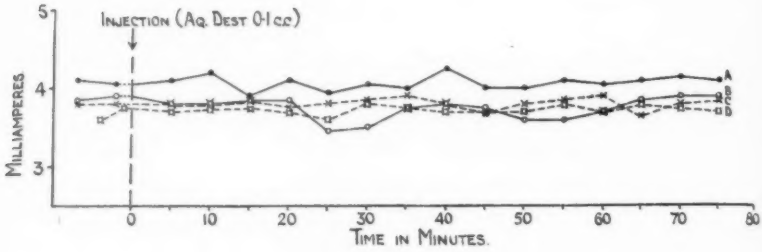

CHART I.

Control Experiments. Fish No. 1.

Generally speaking, a certain irregularity is to be noted in most curves obtained with distilled water. This is due to the very marked stage of excitement which precedes the stage of anæsthesia in the unpremedicated fish, and makes the taking of accurate readings difficult. In the premedicated fish this pre-anæsthetic excitement is very much reduced and often absent. Allowing for these factors, the graphs obtained can be regarded as essentially straight lines.

Pentothal-sodium (Abbot): This short-acting barbiturate was tested in five minnows of varying sizes; three times in Nos. 1 and 5, twice in No. 7, and once each in Nos. 8 and 9. In all cases there was an immediate and marked fall in current dose necessary to produce anæsthesia following the injection of the drug; the figures for No. 5 are shown in Chart II, which shows also the duration of the effect (average 1 hour). The maximum reduction of current varied from 0.9 to 1.45 mA, but appeared to be in the neighbourhood of 1 mA. Variations are partly due to the variable resistance to the drug of different fish, or even of the same fish on different days. It may be due also to the fact that relative dosage, allowing for the size of the fish,

can be only approximately accurate because of the small doses employed.

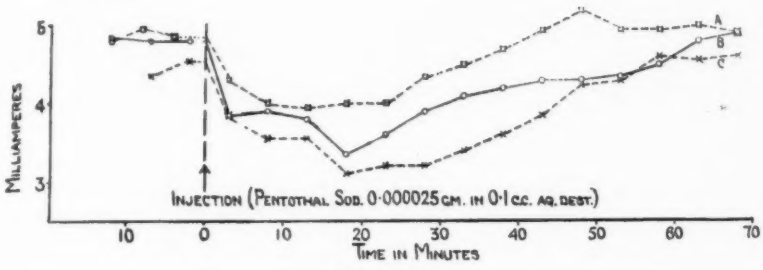

CHART II.

Pentothal-sodium (Abbot). Fish No. 5.

Cyclonal-sodium (May and Baker): This drug was tested in 4 minnows; three times in Nos. 1 and 5, twice in No. 7, and once in No. 8. A typical result is shown in Chart III. The usual initial fall in current was followed by a less pronounced rise 23 minutes after injection, then by a slight fall, after which a steady rise is seen which exceeded the initial current-dose at a time between 38 and 43 minutes after injection. This steep rise near the end of the curve to above the initial current dose may denote a state comparable to the state of excitement following anæsthesia induced by some barbiturates (e.g. evipan sodium) which has been described in clinical practice. The maximal diminution of current varied from 0.85 mA to 1.35 mA, and the average depression was again about 1 mA. The time at which

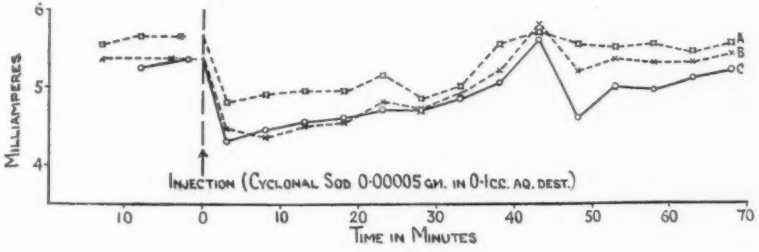

CHART III.

Cyclonal-sodium (May and Baker). Fish No. 5.

minimal effective current-dose was reached varied from 3 to 33 minutes after injection, but was fairly constant on different occasions in the same fish.

Evipan-sodium (Bayer): This drug was tested in 3 minnows, three times in No. 1, twice in No. 5, and once in No. 8. The chemical formula of this preparation is identical with

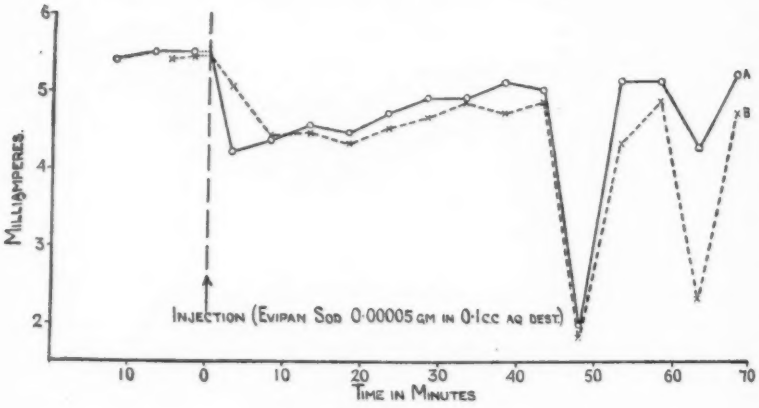

CHART IV.

Evipan-sodium (Bayer). Fish No. 5.

that of cyclonal-sodium (May and Baker), and therefore the same dosage was used. A study of Chart IV shows that a very different type of curve was obtained from that given by cyclonal-sodium. The initial fall was somewhat the same in both drugs. Later there was a quite sudden fall of resistance to the current. At the same time the fish became obviously ill, which was shown either by incoordinated movements or by a stupor from which it was difficult to rouse it. In all cases the minnows recovered.

Somnifaine (Roche): This preparation, which contains two different barbiturates, was tested in two minnows, three times in No. 1, and once in No. 8. Fish No. 1 recovered its original current threshold on two occasions after 73 minutes, and on one after 68 minutes. The average duration of action was again in the neighbourhood of one hour. The time of

maximum effect and its intensity were variable, but the maximum effect seemed rather more pronounced than after the preceding drugs.

Narconumal (Roche): This drug was tested in three minnows, twice in No. 1, once in A and once in C. The duration of action seemed to be remarkably constant at just over one hour, and the maximum diminution of current was also about 1 mA in each case.

Narconumal in Paraldehyde (Roche): This is a stable solution of narconumal produced to avoid the necessity for making up solutions immediately before use. The aqueous solution being unstable, various other solvents were tried and paraldehyde was found to be satisfactory. Ampoules of 1 gm. narconumal dissolved in 3 c.c. paraldehyde were submitted for trial. This solution, diluted by distilled water, was tested as before in two minnows; twice in A and once in B. In calculating the dosage only the content of narconumal was taken into consideration, the content of paraldehyde being ignored, in order to compare this solution with the acqueous solution. The curve obtained was smooth, but it was found that the pre-injection level was reached after 28 minutes in A on both occasions, and after a similar time in B. The maximum diminution of current on all three occasions occurred three minutes after injection, and was 0.65 mA, rather less than that of the aqueous solution. On all three occasions it was noted that the fish became incoordinated, but abnormally excitable to stimulation 18 to 23 minutes after injection.

Comparison between Narconumal in Paraldehyde, and Paraldehyde: Three minnows were used. Fish E was injected with 0.0001 gm. of narconumal in 0.1 c.c. of distilled water, with 0.0001 gm. of narconumal + 0.0003 c.c. of paraldehyde in 0.1 c.c. of distilled water, and with 0.0003 c.c. of paraldehyde in 0.1 c.c. of distilled water. Narconumal produced a regular curve, with a maximum depression of 0.95 mA three minutes after injection, and pre-injection level was reached 68 minutes after injection. Narconumal in paraldehyde gave a smooth curve with a maximum depression of 1.05 mA 3 minutes after injection, but pre-injection level was reached 3 minutes after injection. Paraldehyde gave an irregular curve, with a maximum depression of 0.75 mA 8 minutes after injection, pre-

injection level being reached 48 minutes after injection. The fish showed slight incoordination after the injection of narconumal in paraldehyde, but not after the injection of paraldehyde alone.

Discussion.

This investigation was undertaken to compare the action of the more common intravenous barbiturates now in use, and the following observations were made from this small series of experiments.

(1) Pentothal-sodium (Abbot) showed a fairly constant and smooth action, lasting about 1 hour.

(2) Cyclonal-sodium (May and Baker) showed a distinct tendency towards raising the current-threshold above the pre-injection level, in some cases very considerably so, during the period when the effect of the drug was wearing off. The duration of action was shorter and definitely more variable than that of pentothal-sodium (Abbot).

(3) Evipan-sodium (Bayer) produced a distinctly irregular action and a sudden falling-off of the current-threshold at varying times after injection. In no case was there a return to the pre-injection level after an hour or more. In all cases the fish showed distinct ill effects at some time after injection (Chart IV), though in no case did this cause the death of the fish. In one case the fish became so ill that the experiment had to be discontinued 63 minutes after injection. A striking point is that cyclonal-sodium (May and Baker) and evipan-sodium (Bayer) have an identical chemical formula and yet show a tendency to produce exactly opposite excursions of the curve towards the end of the experiment. No satisfactory explanation can at present be given for this phenomenon.

(4) Somnifaine (Roche) showed a somewhat irregular action lasting approximately one hour.

(5) Narconumal (Roche) appeared to have a constant and smooth action, also lasting in the neighbourhood of 1 hour.

(6) Narconumal in paraldehyde (Roche) caused the fish to become somewhat incoordinated some time after the injection and exhibited an action lasting approximately half the time of that produced by narconumal alone. This is contrary to the

generally accepted view that if two narcotic drugs are given simultaneously, not only summation but potentiation of their actions takes place. At present no explanation can be given for this observation. This mixture has been used clinically in a few cases and it was found either to fail to produce anæsthesia, or to do so only for a few minutes, which was followed by a state of unmanageable excitement which necessitated resort to full gas-oxygen-ether anæsthesia.

It appears from these experiments that of the drugs tested, pentothal-sodium and narconumal are the most reliable and most constant.

The second part of this investigation was aimed at comparing the action of narconumal, narconumal in paraldehyde, and paraldehyde in the same fish. Three fish, one small, one medium-sized and one large, were selected and appropriate doses were injected. In all three fish is was again found that narconumal produced an action lasting approximately twice as long as that produced by an equal dose of narconumal combined with paraldehyde. A dose of paraldehyde equal to that used in the mixture produced an irregular action, lasting for a longer time than narconumal plus paraldehyde and a shorter time than narconumal alone. Even from this very small series, it appears probable that paraldehyde in some way counteracts narconumal, shortening its duration of action to approximately half its normal time. Apart from showing that the solution suggested by the Roche Company is not a practical proposition, this throws doubt on the generally accepted theory of potentiation of action of different narcotic drugs given simultaneously.

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This work was carried out in the Wilkie Surgical Research Laboratory, University of Edinburgh.

PULMONARY COMPLICATIONS FOLLOWING REGIONAL ANALGESIA FOR ABDOMINAL OPERATIONS

BY

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REGIONAL analgesia for abdominal operations is a valuable form of anæsthesia in suitable cases, but as is the case with all forms of local and general anæsthesia, it is not devoid of risks. Pulmonary complications, which are always a source of worry to the anæsthetist, are not unknown.

It is always difficult to obtain accurate figures of the incidence of pulmonary complications following any form of anæsthesia or analgesia, for though the fault in many instances may be in the anæsthetic agent or technique used, it frequently happens that one or other of these is unjustly held responsible for pulmonary conditions, which though first diagnosed post-operatively, had been present and perhaps missed at clinical examination before operation. In the case of local analgesia the task is even more difficult as some form of local anæsthetic is frequently used in preference to any form of general anæsthetic, for a surgical operation on a patient suffering from acute or chronic respiratory disease, and in such a case it may be impossible to determine whether the local analgesia has or has not aggravated the existing respiratory condition.

In this series of 100 abdominal operations, including both "cold surgical cases" and abdominal emergencies, X-ray examination of the chest was made both before and after operation, and cases showing any active respiratory disease present before operation were not included.

The technique of regional analgesia for abdominal operations has been well publicised. For this series the local anæsthetic agent used for the thoracic block was 1/1,000 solution of anethaine (amethocaine) with adrenaline 1/300,000. The lower 6 or 7 dorsal nerves were blocked on both sides,

each injection of about 11 c.c. of anethaine solution was made into the selected intercostal space, at a distance of 4 inches lateral to the spinal column. For the posterior splanchnic block (Kappis method) 50 to 60 c.c. of 1/3,000 solution of anethaine with adrenaline was injected on each side:

Premedication. For this purpose omnopon was found to be the most satisfactory drug, and was given either by hypodermic or intravenous injection. One c.c. of a sterile solution of omnopon containing gr. 1/3 was mixed with 2 to 3 c.c. of sterile distilled water for intravenous use; this was found to mitigate the unpleasant symptoms of nausea, vomiting and sweating which frequently follow the intravenous injection of omnopon, though even with this method the average female patient seldom tolerated more than gr. 1/3, and the average male gr. 2/3 in each dose without developing some discomfort. Repeated doses of omnopon were necessary in most cases; the first dose was given about 1½ hours before operation, the second immediately before the regional block was started and the third dose before the start of the surgical operation. The maximum analgesia effect of the drug was obtained in 2–3 minutes, and maximum narcotic effect in 15 minutes after intravenous injection.

Complications.

The following table shows the number of pulmonary complications in this series of 100 cases:—

		Pneumothorax	Lung abscess	Collapse	Consolidation	Cerebral air embolism	Deaths
Cold surgical cases	73	18 Recovered	1 Recovered	0	1 Died	1 Died	2
Emergency operations	27	1 Died	0	8 3 Died	0	0	4
Total	100	19	1	8	1	1	6

Pneumothorax.

This is a fairly common complication of regional analgesia.

Out of 100 patients 19 developed pneumothorax, one after an emergency operation, and 18 after cold surgical operations.

It is not difficult to puncture the lung, when seeking the intercostal space, especially in a thin, restless patient, or in one with plueral adhesions; and though pneumothorax occurred in patients where the pre-operative X-ray examination of the chest was normal, it was more frequent in those where emphysema was present; this suggested that a puncture hole into an emphysematous bulbar, where the lung tissue had lost a good deal of its elasticity, did not close as rapidly as a puncture hole in healthy lung tissue. Oxygen given under pressure, or vigorous coughing on the part of the patient after a lung had been punctured, was responsible for the development of pneumothorax in some cases. After a cold surgical operation performed under regional analgesia, a patient was conscious, felt well, and had no pain for some hours until the action of the local anæsthetic drug had worn off; he therefore coughed more vigorously to clear the secretions from his bronchial tree than a patient who, having undergone an emergency abdominal operation, felt weak, toxic and too indifferent to cough at all.

Collapse.

Collapse of a lower lobe occurred in 8 patients following emergency operations. As these patients would not cough, the bronchial secretions probably collected, and caused collapse of a lobe by blocking a bronchus.

Consolidation.

Consolidation of one lobe occurred in one patient following a hemicolectomy and proved fatal.

Lung Abscess occurred in one patient following a partial gastrectomy. The patient, a healthy male adult, was edentulous, and had no oral sepsis. The pre-operative X-ray examination of chest showed no abnormal condition. During the operation, which lasted 50 minutes, the patient was conscious and gave no cause for anxiety. After operation his temperature became elevated, he developed a troublesome cough, and his sputum became offensive and copious. X-ray examination of chest, 10 days later, showed an abscess in left lower lobe. He was treated and finally recovered.

Cerebral Air Embolism. This occurred in one patient, and

though it is a rare complication it must be regarded as one of the dangers of regional analgesia. The patient, an adult female, suffering from carcinoma of stomach, was admitted for partial gastrectomy : pre-operative X-ray examination of chest showed slight emphysema. The night before operation, as she complained of sleeplessness, she was given gr. iii Luminal. The premedication, omnopon gr. 1/3, was given intravenously 2 hours before operation, and another larger dose was given, also intravenously, immediately before the regional block was started. During the intercostal block the patient was conscious and appeared comfortable, but when the splanchnic block had been done on one side, she became unconscious and deeply cyanised, the pulse volume was good, and rate a little increased. Oxygen was given through a B.L.B. mask; the cyanosis disappeared, but the respiration remained slow and shallow. When her face was touched she developed generalised twitchings which lasted a few seconds. On clinical examination no sign of pneumothorax was detected; the operation was postponed and continuous oxygen administered; after 1½ hours her pulse became weaker, and she was still unconscious. Cardiac puncture was performed and 1.5 c.c. adrenaline was injected into the heart but patient died 2 hours after the initial collapse. As the thoracic block had been completed in 15 minutes it was thought at the time that the maximum narcotic effect of the drugs on the respiratory centre had coincided with the onset of the intercostal paralysis, and had given rise to the respiratory failure. At the postmortem examination made on the fourth day after death it was revealed that death had been due to cerebral air embolism following puncture of the lungs. The lungs on both sides had been punctured in several places and round each puncture was a small area of hæmorrhage; it was suggested that air had entered the circulation through the capillaries of the lungs and had caused cerebral air embolism. The heart was normal, no air was present on the left side of the heart, but air was present in right ventricle and pulmonary artery. The reason for this was not explained. However, all the cerebral vessels were full of air.

Conclusions. This series shows a 6 per cent mortality from pulmonary complications following regional analgesia but does not include deaths from other complications.

Pneumothorax, which is relatively unknown following general anæsthesia or local field block, appears to be a frequent complication following regional analgesia even in the hands of the expert, but it will be seen that this condition does not necessarily prove fatal.

The respiratory depression which often occurs as the result of the temporary paralysis of the intercostal muscles may give rise to imperfect ventilation of the lungs, followed by anoxæmia and temporary failure of the respiratory centre in many instances. Oxygen, administered through a B.L.B. mask, is sufficient to relieve the anoxæmia, but if the respiratory centre has been narcotised with heavy doses of omnopon it may not recover, and anoxia rapidly develops; it is well to remember that the time taken to complete the thoracic block is about 15 minutes, and if omnopon is given intravenously before the start of the block, the onset of the intercostal paralysis will coincide with the maximum narcotic effect of the omnopon on the respiratory centre; this is often the cause of respiratory depression at this stage. When any pulmonary disease is present before operation the paralysis of the intercostal muscles rapidly gives rise to anoxæmia, and the fall of blood pressure which follows the splanchnic block with this technique will cause anoxia, so in these cases oxygen should be administered continuously from the start of the thoracic block until the intercostal paralysis has worn off.

In the light of the present evidence regional analgesia cannot be regarded as the anæsthetic of choice for all upper abdominal operations irrespective of the general physical condition of the patient, for though the abdominal relaxation is unsurpassed by any other form of anæsthesia or analgesia, and the operative shock diminished by the splanchnic block, it has its limitations and dangers, and until such time as statistics showing the incidence of all types of complications following regional analgesia are available, it will not be possible to determine whether or not the advantages outweigh the disadvantages of this technique.

Summary. Pulmonary complications following abdominal operations performed under regional analgesia in 100 cases have been recorded and classified.

THE MANAGEMENT OF SUBARACHNOID ANALGESIA BY THE CONTINUOUS DROP METHOD

BY

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FRACTIONAL administration, described by Lemmon[1] in 1940, offered a fresh approach to the problems involved in subarachnoid analgesia. Continuing along this line of investigation, Arrowood and Foldes in 1944[2, 3] described the maintenance of subarachnoid analgesia by a continuous drop method. The present report presents the results in 100 consecutive cases conducted by this method.

TECHNIQUE.

The equipment described in previous communications[2, 3] has been changed in only one particular. Instead of the needle valve for regulating the rate of dropping, we now use the New Tunnel Clamp designed by Bradley.[4]

The drug used in this series of cases was procaine. Analgesia is induced by an initial dose of a 2.5 per cent procaine solution and maintained by an 0.5 per cent solution. It is our present practice to dissolve the procaine in physiologic saline containing 2.5 per cent dextrose. This solution was selected in early cases because experience with the fractional method had shown that adequate levels could be established and maintained more easily with dilute solutions of procaine if dextrose was added to them. Results with the drop method proved less consistent when the procaine was dissolved in physiologic saline alone.

The size of the initial dose depends, as in any method, upon the level of analgesia desired and upon the spinal length and physical condition of the patient. To obtain a level to the sixth or seventh dorsal segment in the average patient, 3 or 4 c.c. of solution representing 75 or 100 mg. of procaine is usually adequate. Sensory analgesia to the second or third dorsal segment, as is requisite for upper abdominal surgery, may be obtained by an initial dose of 5 or 6 c.c. representing 125 to 150 mg. of procaine. To maintain the analgesia the clamp is regulated to deliver 0.5 per cent procaine at a suitable rate. This rate varies with the individual patient, but it is usually true that 5 or 6 drops per minute will maintain a level at the sixth or seventh dorsal segment, while it is necessary to administer 8 or 9 drops a minute to keep the level at the third or fourth dorsal segment. Murphy drippers vary slightly as to the size of drop. It is necessary to calibrate each set as to the number of drops contained in each cubic centimeter of solution.

Procedure in conducting the cases is as follows:

Lumbar puncture is accomplished and the initial dose given exactly as would be done in the fractional method. As soon as the injection has been made, the head of the table is lowered 5 degrees and analgesia established to the necessary height. It is important that the anæsthetist assure himself that the initial level is adequate, because if it is not, the subsequent course is likely to be unsatisfactory. When this has been done, the operative field is prepared and operation begun.

The tubing from the levelling flask, which has been filled with 0.5 per cent procaine solution and suspended at a height of 60 to 80 cm. above the spinal needle, is connected to the continuous spinal tubing and the clamp regulated to deliver at the desired rate. In a previous paper we stated that the continuous drop should be started 20 minutes after the initial injection. We have since observed that it is better to begin it a little earlier than that. Our present practice is to begin the drop administration as soon as it is convenient to do so, that is, about 10 minutes after the initial dose.

In the course of our work with the method, several technical points have been observed which it seems worth while to mention. When lumbar puncture is first done, if the cerebrospinal fluid pressure is high and the fluid escapes rapidly, it is

advisable to withdraw fluid until it drops at about the usual rate. If this is not done, maintenance by the drop method is likely to be difficult and unsatisfactory.

The importance of initially establishing an adequate deep sensory level has already been mentioned. If this level is inadequate it cannot be advanced by the drop method using 0.5 per cent procaine even though the superficial skin level becomes very high. If the patient complains of pain from deep manipulations, or if the relaxation becomes unsatisfactory, it is a sign that the level established by the initial dose has been permitted to recede. It should be reinstated by a suitable dose of concentrated procaine solution, such as 50 or 75 mg. in 2 or 3 c.c. The level thus restored may be maintained by the drop method. This measure is not necessary simply to increase peritoneal relaxation for closure. If necessary that may be accomplished by allowing 50 or 60 drops of the 0.5 per cent solution to go in rapidly.

When supplementary anæsthesia is indicated, we induce sleep with pentothal. The total dose of that agent is usually small, and the patient awakes by the time he is ready to leave the operating room.

Discussion of Results.

Data relating to the first 100 consecutive cases conducted by this method have been classified into three tables according to the level of analgesia. In most of the cases this method was chosen because of the expected length of the procedure or on account of the poor physical status of the patient. It was used in 12 cases for repair of hernia for the purpose of training members of the staff as yet inexperienced in this type of administration.

There were two deaths, both unrelated to the anæsthesia. One of these occurred following exploratory laparotomy in a very ill patient who died on the third postoperative day of generalized carcinomatosis. The second death was that of a 63-year-old man who had right uretero-enterostomy and cystectomy for carcinoma of the bladder under continuous subarachnoid analgesia. His postoperative course was compli-

cated by pyelonephritis and thrombophlebitis, for which he had right ureterostomy and bilateral femoral vein ligation. His course was steadily downhill and he died 68 days after the continuous spinal was administered.

Nausea and emesis occurred in eight patients, or in 16 per cent. There was one case of atelectasis of one lobe; and one chill due to a transfusion. There was one complication which might be considered referable to the anæsthesia. This was in a patient who had a radical groin dissection. The following day he had a stiff neck and temperature of 102 to 103 degrees. The symptoms were characteristic of the so-called "aseptic or chemical meningitis." Recovery was prompt.

After the conclusion of our first 100 cases a serious neurological complication occurred. Although in our opinion the complication was not due to the type of spinal anæsthesia employed, but to the fact that owing to an error of judgment spinal anæsthesia was used at all, we feel that it should be reported.

A 41-year-old woman entered the hospital for colectomy with the diagnosis of ulcerative colitis of four years duration. She had had an ileostomy done at another hospital, but despite this she was going gradually downhill. She ran a temperature of around 102 to 103 degrees, was losing weight, and despite repeated transfusions her total protein and hæmoglobin were very low. The surgeons requested continuous drop spinal anæsthesia because of the good results obtained in other debilitated patients. The patient was first seen by us in the operating room. Her back was grossly contaminated by the discharge from the ileostomy opening and she had a decubitus ulcer over the sacrum. An effort was made to cleanse the back as well as possible and a continuous spinal needle was introduced without difficulty. The course of the anæsthesia was uneventful and the patient felt well for five days post-operatively, but despite the penicillin and sulfadiazine therapy she continued to run the same type of remittent fever she had pre-operatively. On the fifth post-operative day she complained of pain in the joints of both legs. The pain was assumed to be rheumatic and the patient was given aspirin. Thirteen days post-operatively, when trying to stand up, she was unable to do so because of paresis of both legs. At the same time she

developed urinary retention. Diagnosis of subarachnoid abscess was made and laminectomy performed. At operation, around the site of the lumbar puncture, a subarachnoid abscess was found containing thick pus. The bacteriological examination revealed gram + cocci. Her temperature subsided following the drainage of the abscess, but complete paralysis of both legs, with areflexia and anæsthesia developed. Her recovery from the point of view of her original disease was satisfactory, and after three weeks she started to gain weight. At about this time the sensory innervation of the legs returned. After about six weeks the motor function of the legs returned gradually and she was able to walk upon discharge from the hospital three months after her operation. Moderate urinary retention still persisted at that time.

TABLE I summarizes the 38 cases in which the sensory level of analgesia was below the sixth dorsal segment. In those patients less than 40 years of age, the course was uneventful. Fall in blood pressure necessitating the use of adrenergic drugs occurred in 16 per cent of the patients in the age group from 40 to 60 years, and in 44 per cent of those patients more than 60 years of age. It should be stated that it is our practice to adminster a prophylactic dose of ephedrine preceding every spinal anæsthesia unless it is contra-indicated. The reference in the tables is to additional doses of these drugs in the course of operation and anæsthesia. Supplementary anæsthesia with pentothal was necessary in 4 cases, or 10.6 per cent.

In this group of 39 patients, 6 per cent were more than 60 years of age. Supplementary anæsthesia with pentothal was necessary in 18 cases, or 50 per cent. Fall of blood pressure needing adrenergic drugs occurred in approximately 50 per cent. In the 10 combined abdomino-perineal resections of the rectum, we administered 6 mg. of pontocaine in 2 c.c. saline and then removed the continuous spinal needle just before turning the patient to the Sims position for the posterior resection. The average duration of that part of the operation was approximately 1 hour (Table II).

More than half of the patients who received spinals to levels above D_4 were between the ages of 40 and 60 years (Table III). It is our practice to begin supplementary anæsthesia with pentothal in cases of subtotal gastrectomy just before the

TABLE I.

Analysis of the cases requiring a sensory level below D_6

Radical groin dissection (6) — Bladder and ureter surgery (9)
Herniorrhaphy (12) — Aneurysm of femoral artery (2)
External genitalia (5) — Exploratory laparotomy (2)
Vaginal hysterectomy (2)

Age in years	Total number	Average dose in mgm. Initial	Average dose in mgm. Total	Average duration	Intravenous therapy used in No. of cases: Glucose	Intravenous therapy used in No. of cases: Blood or plasma	Pentothal used in No. of cases	Adrenergic drugs used in No. of cases	Fall in blood-pressure in No. of cases	Postoperative Complications	Remarks
Below 40	10	110	370	3° 22′	3 (30%)	0	1 (10%) 3.5 gm.	—	—	1 death 2 weeks postop. Not connected to anæsthesia	
40–60	12	112	350	2° 45′	3 (25%)	1 (18%)	3 (25%) Average 0.6 gm.	2 (16%)	2 (16%)	2 nausea and emesis 1 stiff neck (25%)	
Above 60	16	103	292	2° 23′	3 (19%)	5 (31%)	—	7 (44%)	2 (38%)	2 nausea and emesis 1 chill due to transfusion (19%)	

TABLE II.

Analysis of the cases requiring a sensory level between D_4-D_6

Small bowel surgery (15). Combined abdominal perineal resection (11).
Colon surgery (13).

Age in years	Total number	Average dose in mgm.		Average duration	Intravenous therapy used in No. of cases		Pentothal used in No. of cases	Adrenergic drugs used in No. of cases	Fall in blood-pressure in No. of cases	Postoperative Complications	Remarks
		Initial	Total		Saline	Blood and plasma					
Below 40	9 (23.1%)	112	333	2° 28′	2 (22%)	4 (45%)	5 (55%) Average 0.80 gm.	3 (33%)	3 (33%)	1 Nausea and emesis (11%)	In all cases of combined abdominal perineal resection 6 mg. of pontocaine was used at the end of the operation before removing the needle
40–60	12 (30.8%)	121	366	3° 08′	1 (8%)	10 (83%)	6 (50%) Average 0.64 gm.	7 (58%)	6 (50%)	—	
Above 60	18 (46.1%)	130	348	2° 47′	1 (5%)	15 (83%)	7 (39%) Average 0.62 gm.	10 (55%)	10 (55%)	3 Nausea and emesis 1 Incontinentia (22%)	

TABLE III.

Analysis of the cases requiring a sensory level above D_4

Subtotal gastrectomy (16) — Second stage gastrectomy (3)
Cholecystectomy (2) — Exploratory laparotomy (1)
Whipple operation (1)

Age in years	Total number	Average dose in mgm.		Average duration	Intravenous therapy used in No. of cases		Pentothal used in No. of cases	Adrenergic drugs used in No. of cases	Fall in blood-pressure in No. of cases	Postoperative Complications	Remarks
		Initial	Total		Saline	Blood and plasma					
Below 40	4 (17.4%)	160	380	2° 01′	1 (25%)	1 (25%)	1 (25%) Average 0.8 gm.	1 (25%)	1 (25%)	—	
40–60	13 (56.6%)	138	514	3° 17′	—	13 (100%)	11 (85%) Average 1.10 gm.	4 (31%)	3 (23%)	1 Atelectasis (7%)	
Above 60	6 (26%)	145	372	2° 33′	—	5 (83%)	3 (50%) Average 0.85 gm.	3 (50.3%)	3 (50%)	—	

surgeon is ready to mobilize the duodenum to prevent the retching which so often occurs at that time. Anæsthesia with pentothal was thus induced in 60 per cent of this group of cases. Adrenergic drugs were needed in 30 per cent of the cases, as opposed to their use in 50 per cent of the cases shown in the preceding table.

Comment.

Serious complications incident to spinal analgesia fall into two groups:—

1. Neurological sequelæ, such as caudo-equine syndrome and persistent paralyses.
2. Complications occurring immediately after the induction and during the operative period, characterized by profound circulatory depression, with or without respiratory depression.

Lundy, Essex, and Kernochan,[5] and later MacDonald and Watkins[6] have shown that the concentration of the drugs used for subarachnoid analgesia is a large factor in the production of neurological injuries. Recently, Co Tui[7] and associates have confirmed and enlarged these findings. With rabbits as the experimental animals, using three different concentrations of each drug studied, these authors have shown that the extent and duration of nervous tissue changes parallel the increase in concentration of the drugs in the injected solutions. The three drugs used in their study were procaine, monocaine formate and nupercaine. For all of the drugs the effects produced upon nervous tissue by low concentrations were transitory, but with high concentrations the reaction was more severe and more prolonged. Upon the basis of these findings the authors conclude that in selecting the spinal anæsthetic agent the factor of tissue reaction (i.e. the danger of post-operative paralysis) may be eliminated from consideration, and that thus anæsthetic effectiveness and acute toxicity remain the determining factors.

It is our opinion that the immediate untoward effects of spinal analgesia, manifested as profound respiratory and circulatory depression, are brought about by the ascent of the injected solutions to unduly high levels in the spinal canal, with resultant vasomotor and respiratory paralysis, and are rarely if

ever attributable to direct toxic effect from absorption of the drug into the blood stream. Johnston and Henderson,[8] working with dogs, and Koster *et al*,[9] investigating the concentration of procaine in the spinal fluid of human beings, have shown that the injected drug is distributed rapidly and in decreasing concentrations cephalad, and that the concentrations reached at higher levels are proportional to the size of the original dose.

In this connection, it is profitable to examine the exact limits which will afford the patient comfort and the surgeon good working conditions. The muscles of the anterior abdominal wall receive their innervation from the anterior divisions of the seventh to the eleventh intercostal nerves inclusive.[10] White[11] states that the principal sensory fibres from the upper abdominal viscera run with the sympathetic motor nerves, primarily in the major splanchnic nerves. White and Smithwick[12] give the sixth dorsal as the highest level of sympathetic sensory innervation from the abdominal viscera. When motor paralysis is produced to this level the superficial sensory level of analgesia is likely to extend as high as the second or third dorsal segment.

If one proposes to produce by a single injection a spinal analgesia of sufficient extent and duration for the performance of complicated surgery in the upper abdomen, it is necessary to use one of the more potent and more toxic agents and to inject it in such a dosage and concentration that it will arrive at the highest desired level in sufficient concentration to persist for the expected operative period. Sometimes, possibly because the patient is particularly susceptible to the drug, or because of anatomical conditions which prevent the prompt distribution and dilution of the injected dose, such concentrations may cause neurological sequelæ. It is also true that if one induces a motor paralysis which is to persist for two hours or more to the level of the fifth dorsal segment, there will necessarily be a period during the first part of the procedure when the motor level is considerably higher, with consequent undesirable side effects.

The mechanism of action of local anæsthetic agents has not been entirely explained but three statements of Hirschfelder and Bieter[13] are pertinent.

(*a*) Sensory nerves are more sensitive to the local anæsthetics than are motor fibres. The ratio of sensory to motor effects for procaine is 2 : 1.

(*b*) Adsorption of the drug by the nerve fibre is the determining factor in its action.

(*c*) Substances which cause anæsthesia tend to decrease the permeability of the surface layer of nerves.

The sequence of events in spinal analgesia then is probably as follows : after injection into the subarachnoid space, the procaine is adsorbed by the nerve roots. Absorption and detoxification of the drug sets in promptly, but the analgetic effect is maintained by adsorption from the spinal fluid to replace that portion of the original dose which is destroyed. As the concentration in the spinal fluid is reduced the motor nerves are the first to recover.

By our initial dose of procaine, 2.5 per cent, we aim to establish a level just adequate for the proposed surgery. This level is then maintained by the continuous administration of 0.5 per cent solution at such a rate as to replace the drug which is being absorbed and detoxified.

Such a method has the following advantages :

1. Undesirable side effects are reduced to a minimum.
2. The concentration of procaine is so low as practically to exclude neurological sequellæ.
3. The duration and depth of analgesia can be exactly controlled.

Summary.

1. A technique for maintenance of spinal analgesia by the drop method has been described.

2. A series of 100 cases is analysed and discussed.

3. Various pharmacological and physiological facts have been summarized to demonstrate the advantages to be expected from such a method.

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ABSTRACTS

" Clinical Investigation of Kemithal." R. A. GORDON AND A. R. GIBBONS, *Lancet,* May 25th, p. 768.

Kemithal was made in the laboratories of Imperial Chemical (Ltd.) through trying to produce an ultra-short-acting barbiturate with greater margin of safety and fewer disadvantages than other drugs in common use. It was first tried clinically in the Nuffield Department of Anæsthetics at Oxford. Chemically, it is more closely related to evipan than to pentothal, than which it is less potent. For induction before cyclopropane it was injected in 5 or 10 per cent solution. When used as the primary anæsthetic it was given by continuous intravenous drip in 1 per cent solution in normal saline. Induction was smooth in all, and rapid in most cases. The average time for induction with 5 or 10 per cent solution was 20–30 seconds, with 1 per cent solution up to 60 seconds. The amount required was little more than twice that of pentothal. The average amount required for induction was 0.75 gr., maximum 1.0 gr., and minimum 0.3 gr. In 372 patients 5 exhibited intense excitement, 1 developed laryngospasm and 4 had slight muscular tremors. Respiration was depressed in one case. Two hundred and eight patients had kemithal as the principal anæsthetic, 66 without adjuvant, and 142 with the addition of nitrous oxide and oxygen. In all cases there was a slight initial fall in blood pressure with small decrease in pulse pressure; recovery of pressure was complete in 10–15 minutes. There was some increase in pulse rate on induction. There was no case of cardiac irregularity. One case of bradycardia was recorded, the pulse rate decreasing to 48 per minute. Accidental injection into an artery produced pain and vasospastic phenomena in hand and arm relieved immediately by brachial-plexus block. The spasm returned three hours after induction and was relieved by procaine block of the stellate ganglion on the same side. Respiratory depression occurred in 5 patients. Postoperative complications were met in 34 patients. Fifteen

vomited. Lobular or lobar atelectasis developed in 5 patients. This complication appeared to be related more to the site of operation than to the anæsthetic. The average maintenance dose was 1 gr. per hour. The maximum dose given was 7 gr. during 2 hours. Recovery was fairly rapid, usually within 30–45 minutes. The maximum was $3\frac{1}{4}$ hours. There is absence of post-operative depression and of excitement during recovery.

"*Trilene in Dental Surgery*." (*Lancet*, November 10th, 1945.)

A. H. Galley reports on 2,000 cases. He uses the Goldman inhaler, in a single dose method. The apparatus is charged with 1 c.c. trilene, the indicator at "Full." When the fluid has disappeared the arrow is moved to "Off." Indicator moved forward a little with each breath until "On" is reached. It takes about 90 seconds to reach "On," by which time automatic respiration is established. During the first minute about 10 breaths are usually taken, after this the breathing hastens and during the second minute anæsthesia is usually established. Air is given at intervals, enough to keep the colour good. Nitrous oxide, oxygen and trilene by the nasal route proved most satisfactory for long dental operations. It was especially useful for children needing long anæsthesia, cardiac cases, and patients with chronic or acute respiratory infections.

"*Anæsthesiology*," January 1946, p. 9.

Methedrine is more effective than ephedrine as a vasoconstrictor with spinal anæsthesia, and leaves the patient less depressed.

Harrow, Beckett and Hathway (San Francisco) use curare and nitrous oxide for long operations. N^2O and O are given to first plane, then 150–200 mg. curare. This generally leads to 20 to 30 minutes apnœa during which controlled respiration is employed till spontaneous respiration becomes efficient. Lack of oxygen or excess of CO_2 cause respiratory efforts in patients who have had enough curare to cause apnœa. After curare and N^2O there are fewer post-operative complications than after other agents.

Effect of surgical positions on vital capacity. (Ib. p. 31).

The most unfavourable positions as far as interference with vital capacity goes are trendelenburg, lithiotomy and those in which rests are used.

Morphine (p. 59). Movement of a morphinised patient from supine to sitting or semi-erect position may cause vascular collapse. Morphine injected intravenously causes immediate but transient increase in pulse rate and cardiac output.

"*Anæsthesiology*," March 1946.

Treatment of acute arrhythmia during anæsthesia by intravenous procaine. 30–70 mg. have been given intravenously into patients with acute arrhythmia during intrathoracic operations. No untoward effects were observed and the dysrhythmia always improved.

The use of choline and methionine is recommended as premedication to protect the liver and enable the use of chloroform.

Repeated sympathetic blocks have been used for arteriosclerosis trophic ulcer and neuritis, thrombo-angitis obliterous, post-phlebitic œdema and other conditions. 225 blocks were made on 40 patients, 37 were improved. 1½ gr. nembutal were given one hour beforehand.

Anæsthetic convulsions. Primrose and Anderson suggested that these convulsions are due to impurities in the anæsthetic, because all the other factors, high temperature, sepsis, etc., are present in many patients with no convulsion but these occur when impurity is added.

Oenethyl (1-methylaminoheptane) is found to be a good pressor in spinal anæsthesia.

THE DEVELOPMENT OF INHALATION ANÆSTHESIA

1846–1900.

The Wellcome Historical Medical Museum has arranged to publish, in conjunction with the Oxford University Press, an important work on *The Development of Inhalation Anæsthesia* from 1846 to 1900, by Dr. Barbara M. Duncum, of the Nuffield Department of Anæsthetics, University of Oxford, and formerly on the staff of the Wellcome Historical Medical Museum.

The work is to be the first of the Museum's post-war series of Research Studies in the History of Medicine. It deals exhaustively with the history of inhalation anæsthesia in England, the United States of America and on the European Continent, from the scientific and clinical points of view, and shows, as well, the influence of general current events upon this branch of surgery. Most important features of the work are its investigation of the various changes of opinion in regard to the physiological action of anæsthetics, the evolution and practical application of inhalers and other apparatus and the introduction and adoption of anæsthetic drugs, during the period under review. This work, which is illustrated by over 160 photographs and drawings, should prove of especial interest to the student of medical history and, since it shows how modern anæsthetic methods have grown from nineteenth century beginnings, should be of great practical value to anæsthetists and research workers in anæsthetics.

AUSTRALIAN SOCIETY OF ANÆSTHETISTS MEMORANDUM FOR ALL MEMBERS

Relations with the British Medical Association.

The Society's application to be received as a Federal Section of Anæsthesia, B.M.A., is now before the Federal Council. The decision will be notified to all members in due course.

Postgraduate Training in Anæsthesia.

A Diploma in Anæsthesia, involving a gratifyingly high standard of work, has been initiated in the University of Sydney. In Melbourne, the permanent Postgraduate Committee has called for a report on the facilities available for postgraduate instruction in anæsthesia.

The Society naturally approves of the institution of senior qualifications in anæsthesia and of a high standard of qualification for them. It would be sorry, however, to see a series of State diplomata. The ideal plan would be one single diploma for all Australia, or yet better, for all Australasia. The logical body to confer it would be a conjoint board of the Royal Australasian Colleges of Physicians and Surgeons. Whether any such body be within the realm of practical politics is as yet uncertain, but the Society would welcome it and would give it the fullest co-operation in any scheme for the improvement of postgraduate training in anæsthesia.

The Library.

The Society acknowledges with gratitude the gift of a full set of back-numbers of "Anæsthesia and Analgesia," from the outbreak of war to date, donated by Mrs. Laurette McMechan and the executive of the International Anæsthesia Research Society. This generous gift fills an ugly gap in our shelves, but is still more valued for the very nice spirit which prompted it.

The Society is no less indebted to Dr. Noel Gillespie, of Madison, Wis., for the gift of an autographed copy of his book, *Endotracheal Anæsthesia.*

The Society also expresses its thanks to Dr. R. Palmerston Rundle, of Rockhampton, Q., for the gift of a copy of J. F. Silk's *Nitrous Oxide Anæsthesia* (1888).

New books continue to be added as they become available. Members are urged to search their shelves for copies of old books, which will help to complete the Society's historical collection.

Educational Films.

Messrs. Imperial Chemical Industries entertained the Victorian members of the Society to tea and a programme of anæsthesia films on July 24th, 1945. These films, made by Dr. I. W. Magill and his colleagues of the Westminster Hospital, are very good. Messrs. Imperial Chemical Industries have kindly consented to repeat the programme in the other capital cities, so that all members of the Society have an opportunity to view them. Messrs. Imperial Chemical Industries have also suggested the possibility of a donation of copies of the films to our Society, conditionally upon our undertaking to show them in an appropriate manner. This would involve access to talking-film projection apparatus, so that the position needs to be investigated. It is hoped that arrangements can be made, for the possession of a film-library would be of great value to the Society, and the kind offer of Messrs. Imperial Chemical Industries holds out the prospect of securing an admirable nucleus.

Inhalational Therapy.

A request has been received from Messrs. Australian Oxygen and Industrial Gases, Pty. Ltd., for information as to the administration of sulphonamide or penicillin by inhalation, using the Collison type of inhaler (*vide* N. Mutch, *Lancet*, December 16th, 1944). Members are invited to report their experiences in this direction to Messrs. Australian Oxygen and Industrial Gases at 550 Latrobe Street, Melbourne, C.3, or to the Secretary for transmission to this firm.

Drugs and Appliances.

Members desiring to know where drugs or appliances for specific purposes may be obtained are invited to write to the Secretary. He will gladly supply the information if he can, or,

if he cannot, will put the inquirer into touch with those who are able to do so.

Membership.

The death of Dr. M. K. Moss, of Perth, is announced with great regret. Dr. Ethel Robinson (V) is welcomed to membership of the Society. The resignations of Drs. E. C. Black, H. E. P. Ferguson, T. W. Hoggarth, E. Murphy, H. S. Lucraft and H. J. Stubbs are accepted with regret. The Society wishes them all good fortune in their new spheres of activity.

GEOFFREY KAYE.
Hon. Secretary.

14, Collins Street, Melbourne.

GLASGOW AND WEST OF SCOTLAND SOCIETY OF ANÆSTHETISTS

The Society met on February 12th, 1946, in the Southern General Hospital, Glasgow, and the meeting was attended by 35 members and guests. Short papers were read and discussed on the following topics:—

1. Intercostal Block Analgesia—Dr. A. K. Brown.
2. (a) Anæsthesia for tonsillectomy in children.
   (b) Post-operative pulmonary collapse treated by bronchoscopy—Dr. K. C. Grigor.
3. Continuous spinal analgesia—Dr. Violet Young.
4. Cyclopropane as a supplementary anæsthetic—Dr. Julia Middleton.

An equally well-attended meeting was held on March 13th, 1946, in the Glasgow Royal Maternity and Women's Hospital when Dr. Ellen B. Cowan presented a paper to the Society on *Anæsthesia for Obstetrical Cases, Including Self-administered gas/air Analgesia.* The subject provoked an interesting discussion, including a review of the training required for the certification of midwives in the use of gas/air analgesia.

ANÆSTHESIA AT McGILL UNIVERSITY, MONTREAL

A department of anæsthesia has recently been set up at McGill University. Its main objectives are: (1) improvement of teaching of anæsthetics to the undergraduate; (2) enhancement of opportunities for learning anæsthesia by the internes of hospitals connected with the University; (3) maintaining a 3-year diploma course in anæsthesia for those graduates in medicine who desire to become complete specialists; and (4) the development of investigation in anæsthesia in the way of inter-relationship, in the clinic and in the laboratory, and, also, in an interdependent fashion with the University's other departments.

REVIEWS

"*The Conquest of Pain.*" GEORGE BANKOFF, M.D., F.R.C.S. Macdonald & Co. Ltd., London, 1946. pp. 204. Price 6s.

The author traces the efforts to abolish or prevent pain back to their earliest days. Indian, Egyptian, Chinese and Grecian studies and achievements in the realm of pain-combat are described; quotation is made from the Edward Smith Papyrus of about 1600 B.C. Much of the treatment there given is analogous to or identical with that of to-day. Yet the Ebers Papyrus, which is later, upholds the efficacy of magic. The Hippocratic teaching is next considered and scenes given from the life of that practitioner. Then comes the history of Mesmer and Esdaile's employment of mesmerism, and Elliotson's unfortunate experience with it, for he lost his position at University College Hospital because of his practice with that method. Priestley next figures in the tale and the mob's superstitious destruction of his laboratory. Then Humphry Davy carries on the story of progress, though his suggestion for the use of nitrous oxide as an anæsthetic was disregarded for nearly half a century. Similarly Faraday's work with ether attracted none of the attention which it deserved. Gertwerner, who extracted the pure active principles of opium, was called "one of the benefactors of humanity" (1831). Nevertheless he was persecuted as a quack and driven from his own town. The well-known misfortune which befell the young experimenter, Henry Hill Hickman, is related. He died, says the author, "in the midst of his dreams." Long, Morton and Wells figure next in the story of progress towards anæsthesia as we know it to-day. The work of Simpson to popularise chloroform, and his influential writing, must not be omitted. Finally, the author attempts to forecast the future, predicting the use of atomic energy and radium as means of anæsthesia; music, too, "will be harnessed for the benefit of suffering humanity."

"*Ancient Anodynes.*" E. S. ELLIS, M.R.C.S., F.R.A.I. With a Foreword by T. K. PENNIMAN, M.A., Curator of the Pitt Rivers Museum, Oxford. (Wm. Heinemann Ltd., London).

This is not a book to be taken up and read through. It is, however, an excellent book of reference, and the author has delved deeply and comprehensively into all that is known of the earliest attempts at anæsthesia and cognate states. He is not so informative, perhaps intentionally, when it comes to modern methods and agents.

"*Practical Anæsthestics.*" O. ROSS MACKENZIE. (Baillière, Tindall & Cox, London). Second Edition.

This book is an excellent guide for students and practitioners. The author has throughout kept strictly in view the practical demands of safe anæsthesia. He deals comprehensively with the use of all the constantly employed agents and methods and his information and instructions are excellently conveyed in concise and lucid language.